

# Advanced Fuel Cycle Initiative

Technical Monthly - July 2003



## Systems Analysis

### Broad Systems Studies

[INEEL] Prepared timely responses supporting the AFCI/GenIV position on the MIT study “The Future of Nuclear Power”. We identified a number of areas where we are in agreement with the MIT conclusions and agreed to evaluate their concepts further (e.g., deep bore holes), but also clearly delineated those areas where MIT’s conclusions were unsupportable and inconsistent with AFC’s views on closing the fuel cycle (e.g., proliferation, safety, and cost).

[INEEL] Initiated work on a bounding scenarios report and developed a new set of AFC scenarios with increased emphasis on thermal reactor alternatives. Developed specific scenario sets and developed preliminary assessment metrics for economics, waste management, and safety.

[INEEL] Developed a set of major AFCI goals, which are complementary to the eight GenIV goals encompassing sustainability, safety & reliability, proliferation, and economics. The goals are being used to further define criteria and metrics that measure how well various goals can be met.

[INEEL] Began evaluation of high-level drivers from the Yucca Mtn. Project and the Nuclear Waste Policy Act that will influence the AFC analysis.

[INEEL] Reviewed the current AFC economic analysis cost bases and originating data from OECD. Began formulation of an updated AFC cost basis and reviewed past parametric cost models for potential applicability to AFC.

### Transmutation Studies and Integrated Fuel Cycle Modeling

[INEEL] Participated in the AFCI Summer Study conference calls and reviewed the system analysis group results and conclusions. We prepared comments and drafted alternative views and conclusions for consideration.

[INEEL] Performed an initial review of ANL’s DYMOND/DANESS models and LANL’s NWCSim’s model. Made recommendations for FY-04 work scope including various opportunities to collaborate with ANL, LANL, and SNL on model development and definition of potential roles for the INEEL (model development, economics, etc.)

[LANL] Presented to the Steering Committee on Scenario Study on teleconferences and at a meeting at ANL

[LANL] July 31, results of continuing analyses of five reactor scenarios. Results to date include:

- Benchmarked NFCSim against the DANESS code and found good agreement,
- Determined the capacity required to stem the accumulation of SNF for 1.5% growth.

[BNL] Calculations with detailed MCNP geometry models for an isolated Np+Pu MOX assembly, and a “colorset” geometry with one MOX assembly and 3-UOX assemblies have been completed. Initial comparisons for the rod-powers, assembly powers, and k-inf for the colorset are in good agreement with the results obtained by ANL with WIMS8.

[BNL] A detailed MCNP geometry model with Np+Pu MOX fuel based on the ANL Series-1 assembly design has been developed for a Combustion Engineering (CE) System-80 assembly design to see

# Systems Analysis

if the presence of the large water holes results in any significant differences from the results obtained for a 17x17 Westinghouse assembly. The System-80 reactor was designed for full-core MOX. A DRAGON model has also been developed and results for rod-powers and k-inf are being compared to the MCNP results for homogeneous and heterogeneous configurations.

**[BNL]** Several rod-cell calculations for the benchmark proposed by JAERI for the Reduced Moderator Water Reactor (RMWR) have been performed with MCNP and DRAGON. Initial agreement at room temperature is good. MCNP and DRAGON models have also been developed for the full heterogeneous assembly, and initial comparisons are underway. JAERI has provided the additional information requested on the current assembly configuration for the RMWR, including dimensions and enrichment distribution.

## **Repository Impacts**

**[LLNL]** **[LLNL]** LLNL staff participated in the AFCI Scenario Study working meeting at ANL on July 31, 2003. The Systems team is evaluating a limited set of 'nuclear future' scenarios. The results will show the reactor and fuel cycle investments and resources needed and the wastes produced including spent fuel, Pu, actinide and HLW. We are exploring metrics for the waste streams to allow trade studies to be conducted among these disparate parameters. While any given metric for repository benefit can be critiqued from one perspective or another, we are proposing a linear weighted combination of: long-term geologic heat output, near-term operational heat output, regulatory compliance period performance, very long-term performance and possibly volume.

**[LLNL]** Discussions with DOE-RW contractor Booz-Allen-Hamilton indicate that they have a draft report in review at RW on repository cost impacts of AFCI. Pending completion of the MOA between DOE-NE and DOE-RW, we plan to meet in August and discuss the report content.

**[LLNL]** U.S. action items for participation in the NEA study of "Advanced Fuel Cycle Impacts on Waste Management Policy" have been provided to the DOE-RW sponsor, and have been forwarded to AFCI DOE staff for consideration of U.S. response.

**[LLNL]** LLNL provided BCP input for FY-02 carryover, and initial workscope was prepared for FY-04 Systems Studies.

*For more information on Systems Analysis contact Ralph Bennett: (208) 526-7708*

# Separations

## Advanced Aqueous Separations

**[ANL] UREX+ Feed for the Hot Demonstration** – Irradiated nuclear fuel from the Big Rock Point Reactor was dissolved. It is currently being stored and will be analyzed and diluted to 300 g/L uranium before being processed in the 2-cm centrifugal contactors.

**[ANL] UREX+ Demonstration** – The UREX+ demonstration was begun in July using a simulated feed containing uranium, plutonium, technetium, and neptunium at full concentration. The feed also contained full concentrations of zirconium and lanthanum (as a stand-in for total lanthanides) and trace radioactive components (Am-241, Sr-85, Zr-95, Np-239, and Cs-137). The UREX extraction/scrub, UREX Tc-strip, UREX U-strip, and the CCD-PEG (Cs/Sr) demonstrations were completed in July. The remaining simulant flowsheets will be completed in early August, and the dissolved-fuel feed will be processed beginning mid August. The simulant tests will provide an idea of the effectiveness of these processes, but, more importantly, they are helping to develop effective hot-cell procedures for sampling and for decontaminating and re-plumbing the contactors between processes.

**[ORNL] SANEX Process Development** - The focus of the SANEX studies shifted to support for the UREX demonstration test conducted in the facility hot cells. Neptunium and technetium feed stocks were prepared and transferred to the hot cells for adjusting the constituent concentrations of the UREX feed solution. A sample of the uranium and technetium loaded organic phase was pulled during the first hot cell demonstration run for further evaluation in the glove box facilities. Testing of the back extraction of technetium with varying concentrations of dilute nitric acid and hydrazine was completed and samples have been submitted for analysis. A second americium and europium separation test with the BTP extractant over an extended acid range is in progress.

**[ORNL] UREX+ Co-Decontamination Solvent Extraction Hot Test** - Test 1 and Test 2 were conducted during July 2003, using ~8.5L of hot feed in each test.

The hot feed flow rate was ~0.5L/hour, so each run duration was ~17 hours. End stream samples were taken after approximately 8, 10, and 12 hours of hot operation. Organic stage samples from the extraction-scrub and Pu-Np strip contactors were taken after ~14 hours of hot operation, and aqueous stage samples were taken after 16–17 hours. Analyses of the samples are in progress.

**[INEEL] Cs/Sr Extraction Process Development** - Laboratory testing has been completed for initial development of a chlorinated cobalt dicarbollide (CCD)/polyethylene glycol (PEG) based solvent extraction process for the separation of Cs and Sr from dissolved LWR fuel. Based on the results of this testing, a flowsheet has been recommended for testing as part of the 2-cm centrifugal contactor UREX + flowsheet testing planned at ANL-E. A description of the laboratory testing performed and the results of the testing are currently being drafted for submission to a scientific journal. Also, INEEL personnel traveled to ANL-E to observe/assist with flowsheet testing of the CCD/PEG process with simulated feed.

**[INEEL] UREX + Engineering-Scale Experiment** - The 90% design review was conducted on the Engineering Scale Experiment pre-conceptual design currently being completed by Washington Group International (WGI). The High-Level Functions and Requirements document was revised and was approved to incorporate changes in the flowsheet requirements. A document detailing the potential uses for the TAN-607 facility has been drafted and an initial review completed. A Mission Need Statement has been drafted. These two documents will be left in draft form for the project files due to rescoping direction.

**[ANL] ANL-W Support to the UREX+ Engineering-Scale Experiment** - The engineers assigned to support the UREX+ Engineering-Scale Experiment (UREX+ESE) project at the INEEL prepared draft design criteria for the fuel shipment and fuel chopping tasks and gave them to the task manager and Hot Fuel

## *Separations continued*

Examination Facility (HFEF) personnel for review. A meeting was held with HFEF personnel to discuss available and potentially available hot cell space. Based on this discussion the engineers initiated equipment concept models and layouts.

**[WSRC] UREX Hot Demonstration - SRTC** resumed planning efforts to analyze the sludge and hulls from the Dresden fuel dissolution. Results on the six hull samples and first two sludge samples are expected by late August. Six samples of hulls have been cut up and will be submitted to ADS for analysis. Two samples are being analyzed to confirm their identity before the balance of samples are analyzed. Alternative uses for the UREX demonstration raffinate are being considered. The cost and scope to recover Sr from the UREX raffinate [for another potential customer] is being estimated. Currently the raffinate is a waste liability unless SRTC is given direction to use it for an AFCI task.

### **Pyrochemical Separations**

**[ANL] Anode Materials Development** - Two large monolithic RuO<sub>2</sub>-based composite anodes, including current leads, were successfully fabricated for use in the electrolytic reduction cell. Their electrochemical performance and thermochemical stability will be evaluated during the reduction of uranium dioxide.

**[ANL] High-Capacity Oxide Reduction Process Equipment Development** - The second in a series of high-capacity reduction experiments was successfully completed. The cell configuration supported high currents, which resulted in improved reduction rate. Design of the off-gas system allowed for efficient removal of oxygen from the cell, preventing significant reaction between uranium metal and oxygen and limiting corrosion of the cell components, and provided continuous on-line monitoring of the off-gas oxygen concentration.

**[ANL] Laboratory-Scale PYROX Hot Demonstration** - The milestone to initiate laboratory-scale PYROX demonstration was met on July 23, 2003. The

first in a series of electrolytic reduction runs with spent light water reactor fuel was completed in the Hot Fuel Dissolution Apparatus in the Hot Fuel Examination Facility (HFEF). The test employed 50 g of spent oxide fuel. Sampling and analysis of the fuel and process salt are underway, as well as equipment preparation for the next electrolytic reduction run.

**[ANL] TRU Recovery with the Liquid Cadmium Cathode** - The milestone to document cathode processor operating parameters for the liquid-cadmium cathode (LCC) was completed on July 22, 2003. The LCC will be used for transuranic recovery tests that are scheduled for FY04. The parameters were based on a test that was performed in the Fuel Conditioning Facility cathode processor with 27.2 kg of cadmium and 1.4 kg of LiCl-KCl eutectic salt to simulate LCC operations in terms of processing conditions. The test was successful in that more than 99% of the cadmium was recovered in the receiver crucible.

**[ANL] LCC Qualification Testing** - Qualification testing of the Liquid Cadmium Cathode (LCC) assembly was initiated in the FCF Mock-up Area and considerable progress was made. The design of two additional items of handling equipment identified during testing was completed. A meeting was held to review the conceptual model of equipment to recycle the heavy metal recovered in the LCC back to the Mk-V electrorefiner. Agreement was reached on detailed features that will be included in the final design.

**[ANL] Development of Electrolysis Process for TRU Recovery** - Evaluation of the reference electrode system for control of the advanced U/TRU electrolysis cell is complete. The stability of the reference electrode was evaluated over a forty-eight hour period and found to be within the design requirements. Calibration and fit-up testing of the advanced U/TRU electrolysis cell is complete. The cell components and the chlorine gas scrubber system were transferred into the hot glovebox for assembly and subsequent U/TRU recovery tests.



## ***Separations continued***

**[ANL] PYROX Engineering-Scale Hot Demonstration** - Preparation of pre-conceptual PYROX equipment layouts in HFEF is in progress. Evaluation of the impact of a larger scale test on facility safety and environmental regulations (i.e. NEPA and air permitting) was initiated. The proposed scale of this test is approximately 20 kg. [Note: this work has been terminated in accordance with DOE guidance.]

### **Engineered Product Storage**

**[ANL] Engineered Product Storage Forms** - The original MS Excel-based heat transport model for Cs/Sr and Am/Cm was validated by an independently written model developed by UNLV. After validation, the heat transport analysis was finalized by the inclusion of underground storage options and heat transfer of the pure storage form diluted with silica (to simulate general dilution) and mixed radionuclide storage forms. The heat transport model is now being extrapolated to an engineering scale dry storage, wet storage, and deep underground storage facility.

**[LANL] Technetium Product Preparation for Storage/Transmutation** - Electroplating of Tc metal was studied as a potentially convenient method for preparing a thin Tc target for transmutation. Technetium was electrochemically deposited onto an aluminum electrode from an ionic liquid, a tetraalkyl ammonium triflate. The starting technetium compound was  $K_2TcCl_6$  that dissolved on warming to give a yellow solution. After the plating operation the electrode was washed with methanol, toluene and then water. A check of the electrode surface showed the presence of beta activity on the clean electrode surface that was exposed to the Tc solution, confirming the presence of a Tc deposit.

**[LANL] Spent Fuel Treatment Facility Design Safeguards** - DOE-NA and DOE-NE are co-funding the development of a safeguards approach for pyroprocessing facilities proposed by Argonne National Laboratory (ANL). A draft report summarizing the results of Phase I of the project was issued and is under review: "Technology Demonstration Design of

a Proliferation-Resistant Pyroprocessing Facility: NA-NE Joint Fuel Cycle Facility Design Project – Phase I Final Report." Several papers based on this work were presented at the 44<sup>th</sup> Institute for Nuclear Materials Management National Meeting in Phoenix during the third week of July. The results of the Phase I work were also presented to DOE-NA and DOE-NE personnel earlier in July.

**[INEEL] Spent Fuel Treatment Facility (SFTF) Design Support** - A subcontract was awarded to the Washington Group International on August 14, 2003 to perform scoping studies for a Spent Fuel Treatment Facility. A kickoff meeting is scheduled for August 21, 2003. The primary objective of the SFTF Scoping Study is to provide planning assessments of the cost and schedule associated with construction of a large facility to partition various actinides and fission products from LWR fuel, solidify all products, and treat all wastes to applicable acceptance criteria. Secondary objectives include: (a) an evaluation of existing Idaho Nuclear Technology and Engineering Center (INTEC) facilities (Environmental Management) and related infrastructure to determine if they can be utilized to provide any or all of the SFTF functions and (b) an estimate of the resources necessary to further investigate and confirm these preliminary observations and judgments.

**[WSRC] Design Support Activities** - The SFTF deployment plan is being revised to incorporate the most recent spent fuel feed strategy involving interaction with the repository, Pu accountability, and justification for uranium re-enrichment as a preferred alternative. WSRC comments on the SFTF Scoping Study Statement of Work were returned to INEEL. Specific comments referenced the overall storage requirements and staging needs, and review time for the Final Scoping Study. A draft document supporting the need to expedite a SFTF project was generated, and critiqued by members of the Deployment Options activity team during the weekly conference call. A preliminary draft of the MOX deployment plan has been issued for internal review.

## ***Separations continued***

### **Advanced Process Development**

**[LANL] Actinide Crystallization Process** - All the equipment for the nitric acid loop crystallizer has been received and installed. The unit has been satisfactorily tested using air and water. It was operated at a pressure of 15 torr (0.3 psia). Electrical and instrument wiring for the process control unit has begun and is scheduled to be completed by mid-August. (LANL)

**[LANL] Carbonate-based Separation System** - A carbonate dissolution and crystallization process for light water reactor irradiated fuel could significantly reduce costs and production of secondary waste streams relative to the PUREX process. It is well known that  $\text{UO}_2$  can be dissolved in alkaline carbonate solutions if it can be effectively oxidized to the more soluble U(VI). A number of fission products have very limited solubility in carbonate solutions and can be separated by filtration after the initial dissolution step. The potential application of a carbonate dissolution-crystallization scheme to dissolve spent fuel and to separate uranium from fission products and other actinides is being evaluated. Initially, oxidants needed to convert  $\text{UO}_2$  into a soluble U(VI) complex were compared. Hydrogen peroxide,  $\text{H}_2\text{O}_2$ , offered the best properties (among peroxydisulfate, hypochlorite, ozone/water) in terms of fast kinetics and largest capacity for U(VI) in solution. The cation accompanying the carbonate had a substantial influence on the rate of the dissolution in the order  $\text{Li} > \text{Na} > \text{K} > \text{NH}_4$ .

### **EBR-II Spent Fuel Treatment**

**[ANL] EBR-II Spent Fuel Treatment** - During July, four driver fuel assemblies were chopped for treatment in the Mark IV electrorefiner. A batch of driver fuel consists of 6 assemblies. It is anticipated the chopping of the remaining two assemblies will be completed during early August.

**[ANL] High-Throughput Electrorefining** - Preliminary tests with the high throughput anode strongly sug-

gest that efficient removal of uranium from a cathode surface is greatly enhanced by the combination of intermittent scraping of the cathode and high cathode current density. These features have been incorporated into the design of the Planar Electrode Electrorefiner. A preliminary scraping test was performed with the high throughput anode and it was found that the anode drive torque increased by only ~10 in-lbs when a layer of uranium dendrites was present on the cathode surface. The dendrites were deposited in a band 8.5 inches wide on the inside surface of the 10-inch diameter cylindrical cathode tube.

**[ANL] Ceramic Waste Form Development** - An experimental plan to contact salt, ground zeolite, and glass has been written and is in the approval stage at the current time. These experiments will allow continued support of ceramic waste form modeling along with testing the Mechanically Fluidized Dryer for salt and zeolite mixing. These activities support scaling the ceramic waste process equipment to support Spent Fuel Treatment process operations. The first technical evaluation of the three proposals for the prototype production scale ceramic waste form furnace was held. The evaluation team consisted of representatives from electrical engineering, remote systems development, digital controls and information systems, the engineering development laboratory, and waste process engineering. Based on this review, a slightly smaller diameter furnace might instead be pursued to allow for easier operation in HFEF. Contact with the vendors will be made in August. Chemical analysis of the ceramic waste form material used for the alpha damage study was completed. This information will be used to validate leach test results. The final report is being prepared. Samples of ceramic waste form have been analyzed with X-ray diffraction to (1) measure the effect of heat treatment on the relative amounts of sodalite, halite, and nepheline, and (2) correlate the amount of halite that forms when the waste form is processed with the amount of salt loaded into the zeolite and with the relative amounts of salt-loaded zeolite and binder glass. These results address the needs for

## ***Separations continued***

phase stability and composition information required in the DOE Waste Acceptance System Requirements Document (WASRD).

*For more information on Separations contact Jim Laidler (630) 252-4383*

## **Integration**

[NTD] The NTD participated in the review of the so called “summer study” for the quantitative goals and objectives of the AFCI program. The NTD also attended the Transmutation Criteria workshop held in Chicago.

[NTD] Technical summary of fuel development accomplishments for the third quarter of FY03 was compiled and submitted for publication as part of the AFCI quarterly report.

[LANL] proceedings of the “Materials Modeling and Simulations for Nuclear Fuels” workshop held June 9-10, 2003 in Santa Fe, NM was published. The CD was mailed to the participants and the AFCI Fuels NTD.

## **Series One Fuels Design, Specifications and Analyses**

[WSRC] We continued work on the Series 1 MOX Deployment Plan. A working draft was reviewed internally against the SFTF Deployment Plan to help assure consistency between them. Changes are being made and the working draft will be routed to the Fuels Development Working Group for initial review in early August.

## **Series One Fuel Development & Fabrication**

[LANL] The first oxide test pellets for the LWR-1 experiment have been fabricated. The density was lower than the specification, and further developmental tests are being conducted. In one series of tests, the targeted densities ( $95\% \pm 2\%$  theoretical density) were achieved for weapon's grade MOX).

## **Series One ATR Irradiation Experiments**

[LANL] We established a procedure for fabrication of >96% dense hafnia pellets for use, if required, in the LWR-1 fuel pins. For the fuel pin He-bonding, calibrated ring gauges and Go/No Go gauges were received. Zircaloy-4 tubing, end plugs and closure plugs for the fuel pins were machined and delivered for QA acceptance.

[INEEL] All initial TRA required documentation for LWR-1 was prepared and submitted. Also, The Project Execution Plan for LWR-1 was initiated.

[INEEL] We started the Initial physics analysis based on HUD1 material. The three fuel compositions were supplied by LANL.

## **Series Two Fuel Design Specification and Analyses**

[ANL] The AFCI Transmutation Criteria Workshop was attended by a member of the AFCI ANL-W Fuel Development Team.

[ANL] A milestone was met with the issuance of the program document: Metallic Fuel Testing Requirements.

## **Series Two Nitride Fuel Development**

[LANL] The fabrication, physical characterization and packaging and radiography of all the non-fertile and low-fertile nitride pellets for the AFC-1AE test have been completed. Chemical characterization continues.

[LANL] Progress on the study He release from ZrN has been slow regarding conducting the Knudsen Cell experiments at ITU on samples previously shipped from LANL. In order to accelerate this work, additional He-implanted samples of pristine and irradiated ZrN were prepared and shipped to PNNL for release measurements to augment the ITU collaboration.

[ASU, LANL] Study of the effect of nitrogen stoichiometry on mechanical properties of nitrides continued with microprobe analysis indicating that untreated, sintered samples are N deficient with approximately 53 at% Zr and 47 at% N. Post-sinter heat treatment increases the amount of N, leading to a composition closer to being stoichiometric (51% Zr and 49% N). The role of this nonstoichiometry on the hardness of previously measured porous samples



## ***Fuels continued***

is being examined with respect to published data on monolithic ZrN.

**[IC, LANL]** The QM calculations that predict structures and energies of ZrN-TiN solid solutions have been completed. The results have been discussed at meetings Los Alamos and are being used to predict a preliminary phase diagram for the ZrN-TiN pseudo-binary portion of the Zr-Ti-N system.

### **Series Two Metallic Fuel Development**

**[ANL]** Four metallic low-fertile fuel compositions were cast for the AFC-1F irradiation test: U-29Pu-4Am-2Np-30Zr, U-25Pu-3Am-2Np-40Zr, U-34Pu-4Am-2Np-20Zr, and U-28Pu-7Am-30Zr. Fuel segments were sectioned for the six AFC-1F rodlets, and samples were prepared for chemical analysis.

**[ANL]** We issued a report on fuel-cladding chemical interaction (FCCI) for the AFC-1 non-fertile metallic fuel alloys.

**[ANL]** Modifications were made to the differential scanning calorimeter (DSC) to allow better control the input gas flow rate, scrub the oxygen from the input gases, and stabilize the internal pressure. In addition, new Pt crucibles having ceramic inserts were procured and prepared for use. Finally, a new probe holder was installed following seizure of a crucible to a probe holder.

**[ANL]** The scanning electron microscope (SEM) was repaired, ending a 7 week period of inoperability. FCCI sample preparation was initiated.

**[ANL]** A report on modeling of constituent redistribution during irradiation in U-Pu-Zr metallic alloys with minor additions of Am and Np was completed and issued.

### **Series Two ATR Irradiation**

**[INEEL]** AFC-1B and AFC-1D test assemblies and two dummy capsules were successfully installed into

the ATR east flux trap in support of the Advanced Fuel Cycle Initiative.

**[INEEL]** The AFC-1 Experiment Safety Assurance Package was finalized and approved.

**[INEEL]** As-run physics analysis for AFC-1B and AFC-1D during the first 21 days of Cycle 131A was performed and documented.

**[INEEL]** The reactor Primary Coolant System (PCS) was sampled for cadmium each Monday. No increase of cadmium concentrations was detected.

**[INEEL]** Preliminary physics analysis for AFC-1AE, AFC-1F and GFR Materials was initiated.

**[INEEL]** Preparation of the Experiment Safety Assurance Package for AFC-1AE, AFC-1F and GFR was initiated.

**[INEEL]** AFC-1B and AFC-1D test assemblies were received and inspected at the TRA facility.

**[INEEL]** The AFC-1B and AFC-1D Test Plan was approved, finalized and distributed to DOE and the Fuels Working Group Committee.

**[ANL]** The fuel rodlet welding procedure for AFC-1 rodlets was re-qualified in preparation for the upcoming AFC-1AE, F fuel fabrication campaign. Two welders were qualified to the welding procedure specification for AFC-1 rodlet closure welding.

**[ANL]** Rodlet jackets were prepared for the AFC-1AE, F capsules. Cladding tubing was sized, lower end plugs were welded on, and the welds were subjected to radiographic, visual, and dimensional inspection and helium leak tested.

**[ANL]** Fabrication of four AFC-1 cadmium ATR baskets was completed and are awaiting acceptance inspection by INEEL.

## ***Fuels continued***

[ANL] The Final Experiment Description and Design & Data Package for AFC-1AE and AFC-1F Experiments was completed and issued.

[ANL] Two design limits for normal operation of AFC-1AE and AFC-1F were increased to accommodate potential ATR power increases during upcoming irradiation cycles. Program relevance and safety margins were maintained at the new design limits of peak LHGR of 33.0 kW/m and peak cladding inner surface temperature of 550°C.

[ANL] The thermal and stress calculations for the safety analyses of AFC-1AE and AFC-1F were initiated.

### **Series Two FUTURIX Irradiation**

[ANL, LANL] Meetings were held with CEA representatives on July 22-23 in Los Alamos and on July 24-25 in Idaho Falls to discuss issues related to the FUTURIX-FTA experiment. Final compositions for the European fuels were presented: 60%

(Am<sub>0.10</sub>,Pu<sub>0.40</sub>,Zr<sub>0.50</sub>)O<sub>2</sub> in a Mo metal matrix and 60% (Am<sub>0.25</sub>,Pu<sub>0.23</sub>,Zr<sub>0.52</sub>)O<sub>2</sub> in a Mo metal matrix to be fabricated by ITU, and 35% (Am<sub>0.50</sub>,Pu<sub>0.50</sub>)O<sub>2</sub> in an MgO ceramic matrix and 30% (Am<sub>0.80</sub>,Pu<sub>0.20</sub>)O<sub>2</sub> in an MgO ceramic matrix.

[ANL, LANL] Schedule of milestones and deliverables was reviewed and refined. Pressing issue is the initiation of work to resolve transportation issues associated with shipping the metallic fuels to ITU for encapsulation. This activity must be funded in FY04 and initiated early to avoid potential for delay.

*For more information on Fuels contact Kemal Pasamehmetoglu: (505)667-8893*

# Transmutation

## PHYSICS

### Cross-Sections

[ANL] A set of sensitivity coefficients has been generated for the TRAPU-2 and TRAPU-3 irradiation experiments using a simulated adjustment of cross sections.

[ANL] A new evaluation of Am-241 nuclear data was completed. Fission, (n,2n), and (n,3n) reaction cross sections as well as multiplicities for production of Am-242 in the metastable state, were updated by taking into account new experimental data available.

[ANL] A technical paper concerning iron and nickel isotopes, entitled “Neutron-Induced Hydrogen and Helium Production from Threshold to 100 MeV,” was prepared and presented at the ANS AccApp’03 Conference (San Diego).

[ANL] Assembly and characterization of thicker CsI(Tl) stopping detectors continued in preparation for next month’s experimental runs at LANSCE.

[ANL] Initial electroplated chromium foil was tested for oxygen impurity, and was found to be at ~1.5%, which is acceptable for the neutron-induced H- and He-production measurements in chromium.

[ANL] Production of a full set of chromium foils was completed.

[ANL] An order was placed with the LANL Chemistry Division for the fabrication of an Np-237 foil for the actinide-capture cross-section measurements.

### Codes

[ANL] The first order nodal integral approach for fuel-cycle-method code development has been implemented in a prototypic version of the VARIANT code, and the need for high order angular approximations has been verified in several benchmarks that contain low-density nodes.

[ANL] An option was added to the MCNPX code to allow a single collision and escape, enabling direct calculation of double differential cross sections.

[ANL] A number of minor corrections were made to the MCNPX code, including one found by a user in the Netherlands (typo in warning message), netting him a \$20 award.

[ANL] An MCNPX Workshop was held at the M. D. Anderson Medical Center, in Houston, TX, June 16-20.

[ANL] Two MCNPX papers were submitted for publication in the proceedings of the American Nuclear Society AccApp’03 Conference (San Diego, CA): “Neutron Multiplicity Counting for Nuclear Safeguards with MCNPX,” and “MCNPX Advances for Accelerator Applications.”

### MALIBU

[ORNL] The first MALIBU program committee meeting was held in Brussels Belgium at the Belgonucleaire offices. Presentations included an overview of the program, information on the fuel, the measurements, and the expected accuracy of the results. Presentations were also given on MOX-related programs.

[ORNL] The MALIBU schedule calls for the fuel sample to be cut in the next few months and distributed to the laboratories for measurements. The program will be completed in 2005.

[ORNL] The MALIBU participants toured radiochemical laboratories at SCK.CEN in Mol, where some of the isotopic measurements will be performed. A tour of the MOX fuel fabrication facility in near-by Dessel followed the SCK.CEN tour.

[ORNL] Discussions were held regarding contractual matters with the Belgonucleaire sales manager and the MALIBU project manager to discuss options for payment and restrictions on the use of data.

## ***Transmutation continued***

### **STRUCTURAL MATERIALS**

#### **LANL Hot-Cell Activities**

[LANL] Following their irradiation in STIP-1, T-91 and SS-316L specimens are being prepared for hydrogen and helium measurements.

#### **Radiation Damage Modeling**

[LANL] The Fe-He MEAM model was presented in an oral session at the ANS AccApp03 meeting in San Diego.

[LANL] Simulations of high-energy cascade on the Fe and Fe-He systems have begun.

#### **Materials Handbook**

[LANL] The final version of the Materials Handbook Chapter on Tantalum was completed, and the first formal draft of the Handbook Chapter on HT9 12%Cr Steel was prepared for review.

[PNNL] For the ferritic/martensitic irradiated specimen recovery effort, lists of compact tension specimens and tensile specimens thought to be in storage at PNNL were generated, including their irradiation temperatures range and doses.

[PNNL] The data generation and documentation effort on Soviet ferritic/martensitic alloys irradiated in BN-350 and BOR-60 fast reactors has been extended.

### **COOLANT TECHNOLOGY**

#### **DELTA loop**

[LANL] The loop was operated for >5 hrs at temperatures up to 400°C during June. The month's efforts were devoted to reducing the amount of oxygen in the liquid lead-bismuth.

[LANL] A cleaning gas injection line was installed in the melt tank. During installation, oxides were again removed manually from the liquid lead-bismuth's surface and analyzed for composition. Oxygen content had decreased compared to earlier samples.

[LANL] The cleaning gas (6% H<sub>2</sub>/He) was injected

into the melt tank for ~300 hrs. LBE was circulated after 30 hrs of H<sub>2</sub>/He injection to check the oxygen sensor readings. One oxygen sensor (located at the hottest point in the loop) malfunctioned, and the other oxygen sensors did not show improvement. Three new oxygen sensors have been fabricated, and a reusable oxygen sensor design is being developed.

[LANL] We developed an HCP for using oxygen "getters" (such as Mg) in the melt tank. We purchased Mg ribbon, and are investigating possible consequences of using Mg in the loop.

#### **LBE Research**

[LANL] The draft US development program plan for LBE technology was submitted to the OECD/NEA LBE Expert Group as a template to prepare an international joint development plan.

[LANL] A DELTA Loop action plan was prepared and submitted to DOE to re-baseline the 1000-hr corrosion test based on the need to develop and test LBE cleanup methods, and clean the LBE of the excess oxides and oxygen for desired coolant chemistry for corrosion testing.

[LANL] An RGA (Residual Gas Analyzer) system was assembled for use in the DELTA Loop to detect cover gas compositions and to monitor potential leaks or changes in coolant chemistry (in addition to oxygen sensors).

[LANL] A correlation between steel-corrosion rates and the loop's thermal-hydraulic parameters has been developed, explicitly demonstrating the non-local nature of corrosion in test loops. This correlation can be easily used to interpret and categorize various test data.

[LANL] Improvements were made to the induction heater and cooling system of the oxygen-sensor calibration stand, involving the procurement and fabrication of a number of components.

# *Transmutation continued*

## **ACCELERATOR-DRIVEN SYSTEMS**

### **MUSE**

[ANL] [ANL] The analysis of dynamic measurements performed during the MUSE4 experiment was revised using reactivities determined by the Modified Source Multiplication (MSM) method.

[ANL] Measurements taken in the SC2 MUSE configuration with the tritium target were completed. The target will be changed to deuterium in July.

### **MEGAPIE**

[LANL] Review of target drawings and documentation in advance of RFM (Readiness For Manufacturing) continued as the major focus of activity. Most subassemblies were released for manufacture.

[LANL] An internal PSI cost assessment was completed. Deviations from selected vendors were noted, but overall prices were in general agreement, so fabrication can begin.

[LANL] A result of a MEGAPIE Steering Committee Meeting was an agreement to delay start of irradiation until July 2005, following the planned delivery of the target to PSI in May 2004.

[LANL] Other DOE contributions to the MEGAPIE Project included: (1) Review of target drawings and documentation, (2) identification of open issues for some components, and (3) continued work on reliability study. A preliminary "living" reliability assessment document was released.

### **TRADE**

[ANL] The TRADE Target Design Subgroup met twice to finalize a new design of the Ta target that complies with the new requirements for the proton beam (140 MeV proton energy). A new reference design has been produced and is undergoing review.

[ANL] Approvals were granted to transport the miniature fission chambers to Casaccia for use in the TRIGA reactor for TRADE. Also, detectors from Photinis are expected before September; so it appears that all is coming together for an extensive experimental campaign in the fall.

[ANL] MSM (Modified Source Multiplication) method factors were generated at different locations for four different subcritical configurations of TRADE with control rods all inserted as requested by experimentalists. These factors are used for the experimental planning of the subcritical reactivity measurements.

## **UNIVERSITY PROGRAMS**

### **University of Texas at Austin**

- The proliferation resistance assessment methodology was used to produce results for thirteen cases for the Blue Ribbon Committee on Nuclear Non-proliferation. Feedback from the committee, which has been very positive, was used to adjust weighting factors and to improve the methodology. Visual coding and documentation for the methodology and the coding is being completed.
- Evaluations of cross-section uncertainty sensitivities were performed for a full-core ADS simulation and a full-core fast reactor simulation using a PVM version of MCNPX linked to ORIGEN and NJOY99, and is now being documented.

### **University of Florida**

- Non-isothermal Thermo-Gravimetric Analysis (TGA) oxidation scans of HT-9 stainless steel were completed.
- Data are being compared with the results obtained for the non-isothermal oxidation scan of SS-316L. The weight change per area vs. temperature for SS-316L follows the same trend as HT9 stainless steel from room temperature (RT) to 800°C.

### **North Carolina State University (NCSU)**

"Calculations of Radiation Damage at SINQ Target 5" was presented at the ANS AccApp'03 Conference. Two figures of special interest were displayed, containing color-coded contour maps with the structural layout of Target 5 overlaid (layers of the various Pb target rods, specimen rods, and empty rods), correlating the shapes of the color contours with structural and materials features in Target 5. There are some surprises in the contour shapes that



## ***Transmutation continued***

are under investigation.

### **UC Berkeley**

- The simplified model for searching for the equilibrium composition of a once-through molten-salt transmuting reactor was improved, reducing the search time by an order of magnitude.
- A study of the sensitivity of the molten salt reactor performance to the molten salt feed rate was completed, indicating that criticality can be achieved and an equilibrium actinide concentration can be maintained below the solubility limit over a wide range of feed rates. The fractional transmutation becomes larger with a smaller feed rate. The graphite-to-MS volume ratio giving the peak  $k_{\text{eff}}$  is between 2 and 3.
- Two papers were submitted for publication in the proceedings of the ANS AccApp'03 Conference (San Diego), "Molten-Salt Type Effect on Once-Through Molten-Salt Transmuters Characteristics," and "Cycle Dependent Fuel Inventory Evolution from ATW Fuel Cycle," and one paper submitted to the ANS GLOBAL'03 (New Orleans), "Reduction of TRU Toxicity in LWR-Spent Fuel by Reference ATW System with LBE-Cooled Subcritical Transmuters."

### **University of Michigan**

- We completed a second irradiation of HT-9 and T-91 alloy TEM bars to 3, 7 and 10 dpa at 450°C at He-implanted and non-implanted conditions, which will be used for corrosion measurements in the DELTA loop at LANL.
- With active support from Westinghouse Electric Company, effort is underway to develop a global fuel-cycle model for the AP1000 core with the Phenix and ANC codes (to which we have recently been granted full access).

- Two papers were submitted for publication in the proceedings of the ANS AccApp'03 Conference (San Diego): "Assessment of Materials for Accelerator Applications using Proton Irradiation," and "Space-Time Correction in Reactivity Determination for Subcritical Systems."
- Three papers have been submitted for publication in the proceedings of the ANS GLOBAL'03 Conference (New Orleans): "Transuranics Transmutation Characteristics of Denatured Thorium in Fast Reactors," "Effects of Stockpile Spent Fuel Feed on Recycling Self-Generated Plutonium in PWRs," and "Evaluation of Different Reactivity Definitions for Subcritical Systems."

### **University of Illinois**

- We completed the assembly of a gas system for delivering controlled partial-pressures of oxygen, hydrogen, and water vapor that will provide specific oxidation potentials in an LBE system.
- A paper was submitted for publication in the proceedings of the ANS AccApp'03 Conference (San Diego): "The Use of Impedance Spectroscopy to Measure Lead-Bismuth Corrosion."

### **LANLAFCI University Programs Leader**

- Two purchase requests for University research projects were submitted to LANL Procurement: one for NCSU to develop an international database (library) of damage cross sections, and another for UC Berkeley to provide input data on impacts of recycling and transmutation on repository performance for LANL systems analyses.
- A "Modeling and Measurement of Helium Bubble Effects" project was initiated at UIUC, using a variety of methods to examine effects of He bubble size on properties of steels.
- Discussions were held between LANL and NCSU to support LANL's systems modeling efforts, and between LANL and Texas A&M for support of LANL's Gen IV research programs.

## ***Transmutation continued***

- The AFCI University Programs Leader ran the technical program of the sixth international topical meeting “Nuclear Applications of Accelerator Technology: AccApp’03,” which was imbedded in the ANS summer meeting in San Diego, and has begun a one-year elected position on the Accelerator Applications Division of the American Nuclear Society.

*For more information on Transmutation contact:  
Mike Cappiello (505) 665-6408*

## **UNLV Transmutation Research Program (TRP)**

### **Administration**

Prior month's issue was resolved and remaining FY03 funding was received and subgrants to faculty were set up.

Major facility modifications are underway for the Transmission Electron Microscopy User Facility and an interim Actinide Chemistry laboratory at the Harry Reid Center for Environmental Studies. The TEM room modifications are on schedule and completion of the room is expected by the end of September. Both of these facilities are expected to be operational by November.

The UNLV TRP Deputy Director and International Programs Adviser visited the Khlopin Radium Institute in St. Petersburg, Russia, to review progress on active collaborations (Tasks 15 and 16) and discuss potential future collaborations.

## **UNLV TRP Student Research**

### **UNLV TRP Fuels**

#### **Design and Analysis for Melt Casting Metallic Fuel Pins Incorporating Volatile Actinides (Task 1)**

The mold filling process and the solidification modeling have been combined and simulated together using the VOF-solidification algorithm. The solidification could take place during the filling process.

Since the casting process is very difficult and complicated, the software FIDAP alone is not enough for this kind of numerical simulation. Thus, two FORTRAN subroutines have been developed to link with FIDAP in the calculation.

In the casting process, the velocity profiles are found increasing rapidly and then dropping off as solidification occurs.

A new system design using a plug at the end of the mold which can control the backward pressure inside the mold has been suggested by ANL-West. Hence, two fluids VOF method will be used to include air and melt during the casting process. Efforts are beginning on the development of a numerical model that assesses the impact of americium

transport from a heated melt. The heating rates with temperature profiles with the different power deposition to the crucible have been studied

### **UNLV TRP Separations**

#### **Development of a Systems Engineering Model of the Chemical Separations Process (Task 8)**

- Implemented the Object Oriented Programming approach which remains three sections: First, Intermediate, and Last. Move command is also implemented to all the above three sections.
- The database has been created and tested using ACCESS of Microsoft. SQL server has been used to implement the database design.
- Tables were modified completely so that redundancy is reduced. Four tables can take all the data from the VB interface.
- Tables have been designed for output so that reports can be generated from the developed interface by NCACM instead of AMUSE. Each table has filename as primary key so that foreign key relationship can be established.
- Several runs were made and charts for different inputs versus outputs were created. Based on these charts we have got some relationship between input and output which can be used for the optimization process in the system engineering modeling.
- The FLOWSHEET SIMULATOR code has been developed and is in use for the systems evaluations.

#### **Nuclear Criticality Analyses for Transmuter Fuel Fabrication and Reprocessing (Task 11)**

Continuation of summer internship of UNLV graduate student Elizabeth Bakker at Argonne National Laboratory

Formulation of heat transfer program in MathCAD

which determines maximum temperature inside storage form.

Investigation of heat transfer tendencies of mixtures of americium oxide, curium oxide, cesium oxide, and strontium oxide.

## Immobilization of Fission Iodine by Reaction with a Fullerene-Containing Carbon Compound and Insoluble Natural Organic Matrices (Task 15)

Breakthrough experiments with the FCC material were carried out. The FCC pellets that were received from KRI were crushed with a mortar and pestle and packed into the glass column. The particle size distribution was not determined, however, the pressure required to achieve 20.0 mL/min flow rates for the FCC column was significantly higher than with the NOM columns. The concentration of iodine in the vapor phase was  $1.36 \times 10^{-5}$  mol/L.

The gas phase was approximately 50% saturated with nitric acid vapor as well. Experiments were conducted at a flow rate of 0.020 L/min

Tested iodine exposed FCC material to various leaching procedures. Leaching of freshly exposed FCC with 0.1 M KI removed all of the "sorbed" iodine.

Leached FCC material previously exposed to iodine at KRI.

We have tested various bases with NOM for their effect on iodine sequestration.

Continuing to investigate SPME analysis of methyl iodide.

Developed a calibration procedure for methyl iodide that is released by pyrolysis.

Started investigating the utility of hydroxide charged anion exchange resin for methyl iodide trapping. We are investigating the efficacy of removal of iodide from various strongly basic anion exchange resins. We are also investigating the potential of a mercaptan group (-SH) containing resin for methyl iodide trapping.

## Evaluation of Fluorapatite as a Waste-Form Material (Task 16)

NEXAFS spectra for the apatite samples have

been measured this month. The obtained spectra are as follows:

- Calcium L-edge NEXAFS for the hydroxylapatite, fluorapatite (clear crystal) and hydroxylapatite mixed with Zn powder,
- Oxygen K-edge NEXAFS for hydroxylapatite and fluorapatite (clear crystal),
- Phosphorous K-edge NEXAFS for hydroxylapatite and fluorapatite (clear crystal), and
- Fluorine K-edge NEXAFS for fluorapatite (clear crystal).

Samples of synthetic fluorapatite and the model natural fluorapatite were obtained from the KRI collaborators.

Obtained Photoacoustic IR and IR imaging for two apatite samples from Russia. Identification of each signal of those IR spectra is in progress.

## **Issues**

Last month's issue was resolved and Task 15 received fullerene-containing carbon compounds from Khlopin Radium Institute collaborators.

## **UNLV TRP Transmutation Sciences**

### Modeling, Fabrication, and Optimization of Niobium Cavities (Task 2)

Completed assessment of particle position detector. Re-examining the multipacting code for multipacting from muffin tin geometry.

Revised the optimization routines for determining cavity geometry from resonant frequency and mode calculations.

Flow studies are being conducted.

Modified baffle parts ordered and minor construction begun.

### Experimental Investigation of Steel Corrosion in Lead-Bismuth Eutectic: Characterization, Species Identification, and Chemical Reactions (Task 3)

A manuscript describing our work was submitted to the *Journal of Nuclear Materials* in early July. "Spectroscopic and Microscopic Investigation of the Corrosion of 316/316L Stainless Steel by Lead-Bismuth Eutectic (LBE) at Elevated Tem-

peratures: Importance of Surface Preparation,” by Allen L. Johnson, Denise Parsons, Julia Manzerova, Dale L. Perry, Dan Koury, Brian Hosterman, and John W. Farley.

## Environment-Induced Degradation and Crack-Growth Studies in Candidate Target Materials (Task 4)

SCC tests using self-loaded C-ring and U-bend specimens are ongoing in aerated acidic solution at ambient temperature and 50°C. These test specimens are being periodically withdrawn from the cells for verification of crack initiation by optical microscopy. SCC testing in molten LBE using similar types of specimens will soon be initiated at LANL.

Simultaneously, SCC testing using smooth and notched tensile specimens of Alloys EP-823, HT-9 and 422 are ongoing under constant load in the MPL.

SCC testing under controlled cathodic potentials (with respect to the corrosion potential) has been initiated.

Fractographic evaluations by scanning electron microscopy are being continued. Microstructural analyses by optical microscopy are also in progress.

## Modeling Corrosion in Oxygen-Controlled LBE Systems with Coupling of Chemical Kinetics and Hydrogen Transport (Task 5)

Chao Wu successfully defended his M.S. thesis and received his M.S. degree on July 24. His thesis title is “Study of Geometry Effects on Local Corrosion Rates for LBE Loop.”

Examinations of sudden expansion geometries were carried out in 2-D and 3-D models. Uniform Temperature along the length of the plate is assumed. A uniformly generated mesh is used. Different mesh sizes were tested to check the mesh independence.

Preliminary results: initially, flow does not contain any species at inlet, while two plates have a fixed concentration of species. In this way the species on the plates will diffuse into the bulk region, and the expected corrosion rate along the length may vary due to the difference of local flow condition and concentration profiles normal to the

wall. Hopf bifurcation occurs in this kind of symmetric sudden expansion domain, when Reynolds number reaches a certain critical value. Oscillation or vibration appears in the flow and the resultant flow becomes unsteady and periodic in time. Results verified by addition of monitoring cell to models. Mesh independence also examined.

## Neutron Multiplicity Measurements of AAA Target/Blanket Materials (Task 6)

Finalized the computations and the graphical depiction of these results of nuclear transport models for the neutron production source volume, neutron capture efficiencies of specific elements of the NucSafe  ${}^6\text{Li}$  glass 6-element detector systems. Relative energy deposition in the detector was also graphically depicted. Transport code models of a modified, small-scale cylindrical target with an inverted cone are now being constructed.

The 304 Stainless Steel stand for  ${}^3\text{He}$  detector system was delivered and sited in the HRC RDL. Eight nuclear grade lead bricks were modified to fit into the target area of the  ${}^3\text{He}$  detector system stand.

The glass fiber neutron multiplicity detector prototype ( ${}^6\text{Li}$  glass fiber detector) is ~96% complete for all hardware and electronic card production (for optoelectronic interfaces, light guides, signal train, firmware). Standoff electronics shielding has been completed.

Prompt signal circuitry needed for the detector to communicate with the cyclotron signals is ~98% completed. This timing circuit “trigger” is needed for communicating with the beam timing system at the Crocker Nuclear Laboratory (UCD).

Production of detector material ( ${}^6\text{Li}$  glass fiber) detector elements for the prototype sensor were completed and tested for response by spectrophotometry. Detector housing and light-tight enclosure testing commenced in the third week of July 2003.

## Development of Dose Conversion Coefficients for Radionuclides Produced in Spallation Neutron Sources (Task 7)

John Shanahan completed and defended his M.S.



thesis.

The quality check of the DC methodology/procedures has been completed in collaboration with Keith Eckerman (ORNL) and other university partners.

The work was presented at the Health Physics Society Annual Meeting (San Diego, CA), and received the Best Student Presentation award (for J. Shanahan).

Continued the search on the nuclear data bases for the Category 2 radionuclides.

Completed the Category 1 radionuclides which have complete ENSDF files.

## Development of a Mechanistic Understanding of High-Temp Deformation of Alloy EP-823 for Transmutation Applications (Task 10)

High-temperature tensile testing using specimen grips made of maraging steel in the presence of nitrogen is in progress. Testing so far has been performed at ambient temperature, 100°C and 300°C. Data analyses are ongoing.

Future tests involving tensile specimens of Alloy EP-823 will be performed at 400, 500 and 600°C. Optical microscopy and SEM will be used next to evaluate the metallurgical microstructures and fractography, respectively.

## Radiation Transport Modeling of Beam-Target Experiments (Task 12)

Continuing to build onto Beowulf cluster. A total of 23 slave machine, 2 dual CPU masters are up and running. Another 15 slaves have been ordered and will arrive next month.

Continued benchmarking on shared memory systems and Beowulf cluster. Also testing between MPI versions and PVM. MPI seems to be outperforming PVM by a factor of 3 on the Beowulf cluster. Runs are currently being conducted on the shared memory systems.

The new machines are AMD 2400's while the older slave machine were AMD 2000's. PVM now has the ability to load share. Testing is being done on this. MPI does not currently support load sharing and will

need another device to incorporate slave machines with different CPU speeds.

## Developing a Sensing System for the Measurement of Oxygen Concentrations in Liquid LBE Systems (Task 13)

Training of students for their visit/work in LANL completed.

We have installed the software FLUENT into the newly acquired SUN server. Some preliminary simulation results on 3-D have been obtained for a simplified model.

A study regarding the noise feature of the sensor was started.

## Use of Positron Annihilation Spectroscopy for Stress-Strain Measurements (Task 14)

Measurements of residual stresses in welded specimens consisting of similar and dissimilar materials of heat-treated Alloy EP-823 and Type 304L stainless steel by positron annihilation spectroscopy (PAS) are ongoing at the Idaho State University (ISU). PAS data on three-point-bent specimens are also being analyzed.

Metallographic evaluations of welded specimens by optical microscopy are in progress.

A proposal to perform residual stress measurements by neutron diffraction is undergoing a formal review by the Atomic Energy of Canada Limited (AECL).

A new heat of Alloy HT-9, vacuum-melted at the Timken Research, is currently being processed for specimen preparation.

*For more information on the UNLV Transmutation Research Program contact: Tony Hechanova at 9702) 895-1457.*

## University Research Alliance - Fellowship Program

### University Programs

FY02 Fellow Jennifer Ladd-Lively, Chemical Engineering, University of Tennessee, Knoxville, is working at ORNL through the Higher Education Research Experience until the end of August. She is working on research related to her thesis topic. Jennifer will resume classes in late August, and will be completing her coursework during the fall semester and finishing her thesis in the spring. She is also working on modeling the dissolution of fluoride residues in water.

Several Fellows will submit posters for the AFCI Semi-Annual Meeting:

- 2002 Fellow Lisa Cordova, Nuclear Engineering, University of New Mexico, will send a poster titled, “Determining an Optimal Size for An Elastic Scattering Approximation.”
- 2002 Fellow Jennifer Ladd-Lively will have a poster titled, “Overview of Research: Separation of Fluoride Residue Arising from Fluoride Volatility Recovery of Uranium from Spent Nuclear Fuel.”
- 2002 Fellow Frank Szakaly, Nuclear and Radiological Engineering, Texas A&M University, will present a poster titled, “Status Report on Thorium-Based Series II Nitride Fuel Modeling.”
- 2002 Fellow Lee Van Duyn, Nuclear Engineering, Georgia Institute of Technology, will have a poster titled, “An Evaluation and Analysis of a Metal-Matrix Dispersion Fuel.”
- 2002 Fellow Will Wieselquist, Reactor Physics, North Carolina State University, will present a poster titled, “A Nuclear Data Sensitivity Analysis Tool for Reactor-Based Transmutation Concepts.”
- 2002 Fellow Shafaq Amdani Moten is, at the

time of this writing, on a leave of absence from the program. Shafaq, who began studying for her master’s at the University of Illinois at Chicago, majoring in Physics, has indicated that she intends to change universities and is seeking a research topic of interest to the AFCI program (a contingency requirement for reinstatement into the fellowship program).

- FY01 Fellow Preston Pratt graduated with a master’s in Nuclear Engineering from Texas A&M University. We have received his thesis and have forwarded it to Buzz Savage.

Management-wise, URA has developed and submitted a plan to Buzz Savage that merges the university research component of the AFCI program into the AFCI University Fellowship Program.

The theses for which we have received permission to post on the studentpipeline.org web site are now available to be downloaded. At this time, the following theses are available:

- Coy Bryant, University of Texas, Nuclear and Radiological Engineering: Developing Computer Models for the UREX Solvent Extraction Process and Performing a Sensitivity Analysis of Variables Used for Optimizing Flowsheets for Actinide Transmutation
- Benjamin Milliron, Ohio State University, Nuclear Engineering: Use of the Fluoride Volatility Process to Extract Technetium from Transmuted Spent Nuclear Fuel
- Michael Gregson, University of Texas, Nuclear Engineering: Full Core Analysis of ATW Prototype for Development of Nuclear Cross Section Data for Critical Core Components
- Leigh Outten, Massachusetts Institute of Technology, Nuclear Engineering: Development of a Master Logic Diagram and Event Trees for an Accelerator Driven System

## ***University Research Alliance - Fellowship Program***

- Preston Pratt, Texas A&M University, Nuclear Engineering: A Three Dimensional Simulation of a Thermal Experiment Conducted on an Accelerator Driven System Target Model Concept

URA is querying the AFCI Fellows' advisors on the dates that are most workable for faculty and students for the key parts of the fellowship/research program – specifically the best date to announce the new fellows, the best dates to request letters of intent and proposals, and the best dates by which will make research awards.

URA researched national laboratory summer salaries for AFCI fellows and found the following: AFCI fellows who worked at a national laboratory over one or more summer breaks worked an average of 9.25 weeks and made an average of \$15.17 per hour.

University Research Alliance is working to refine the tools we use in managing the constantly changing data we receive on each of the Fellows.

University Research Alliance is developing program announcements for the FY04 Fellowship program, which we anticipate will include both master's and Ph.D. students.

*For more information on the University Research Alliance contact: Cathy Dixon at (806) 376-5533*

## ***Idaho State University / Idaho Accelerator Center***

Dr. Denis Beller, a visiting research professor at ISU, initiated a multi-university collaboration to conduct a series of accelerator-driven subcritical systems (ADSS) experiments at ISU, UT-Austin, and Texas A&M to examine coupling and transient response. The ADSS experiments will involve using electron linacs to produce neutron sources for a compact, transportable nuclear reactor at the Idaho Accelerator Center and TRIGA reactors at UT and Texas A&M. In addition to these three universities, UNLV faculty and students will also be involved in designing, predicting performance of, and conducting these experiments.

Dennis Beller joins ISU/IAC as a Research Faculty in a part-time position. Beller will organize and direct the formation of a University ADSS teaching and research facility, as a joint project between UT, Austin TX, A&M, UNLV, and ISU/IAC.

A 40 MeV linac for ADSS and for neutron irradiation effects on oxygen sensors has been completed and is undergoing tests at the IAC.

A LBE neutron/irradiation target for oxygen sensor testing has been fabricated and is undergoing thermal tests at IAC.

A high repetition rate accelerator for positron stress technology is operational in a new accelerator hall at the IAC. A 1000 Hz repetition rate 6 MeV linac is being used for Positron Annihilation Spectroscopy (PAS). This new machine increases signal to noise in PAS measurements of stress by a factor of more than 3 over the previous accelerator.

*For more information on the Idaho State University Program, please contact Frank Harmon at (208) 282-5878.*

## ***Technical Integration***

[SNL] Continued preparations for AFCI Semi-Annual meeting in August. Arrangements for hotel rooms and meeting rooms were made with the La Fonda Hotel in Santa Fe. A draft agenda was released.

[SNL] The development of an AFCI Key Activity and Decision Plan continued. This chart summarizes key AFCI activities and program decisions from now through 2025. The plan was revised plan to incorporate feedback from the DOE program element managers and NTDs received the week of June 23rd in Washington, D.C. Further development of the plan is currently on hold as the program incorporates new direction in its planning.

[SNL] Initiated economic analysis section of AFCI Summer Study for P.J. Finck/ANL

[SNL] Compiled FY04 budget information from NTDs and distributed budget for three scenarios.

[SNL] Provided support and analyses to the Systems Analysis Working Group scenario studies.

[SNL] Attended Scenario Steering Committee Meeting at Argonne National Laboratory (Chicago, IL)

***For more information on Technical Integration  
contact John Kelly: (505) 844-8993***